VOLUME IX. NUMBER 2

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR

C. A. CHANT
University of Toronto, Toronto

ASSOCIATE EDITORS

W. F. KING
Chief Astronomer
Ottawa

R. F. STUPART
Director of the Meteorological Service of Canada, Toronto

J. S. PLASKETT
Dominion Observatory
Ottawa

PUBLISHED MONTHLY

February, 1915

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.
FOREIGN AGENTS: WILLIAM WESLEY & SON,
28 ESSEX ST., STRAND, LONDON.

THE JOURNAL

OF THE

ROYAL ASTRONOMICAL SOCIETY

OF CANADA

VOL. IX. FEBRUARY, 1915. No. 2

The Sidereal Universe	*(President's Address)*	*J. S. Plaskett*	37
The Claims of Meteoric Astronomy		*W. F. Denning*	57
Large Meteors in June		*W. F. Denning*	61
Meetings of the Society			
Report of Annual Meeting		*J. R. C.*	63
Notes from the Dominion Observatory			
Note on d Tauri		*W. E. Harper*	79
The Second Spectrum of α Ursæ Majoris and h Persei		*J. S. Plaskett*	80
Review of Publications		*C. A. Chant*	82
Notes from the Meteorological Service			
Report of the Weather in Canada, January		*R. F. S.*	86
Italian Earthquake, Records at Toronto and Victoria, B.C.			88
Earthquake Records at Toronto and Victoria, B.C.		*J. Y.*	89
Magnetic Observations		*R. F. S.*	90
Comet News		*C. A. C*	91
Astronomical Notes			
Star Streams			93
Absorption of Light in Space Uncertain			94
Moving Picture Records of Solar Eclipse of August 21, 1914		*J. R. C.*	95
Notes and Queries			
Fall of an Erolite			99
A Bright Meteor in Alberta			100
Audibility of the Aurora		*C. A. C.*	100

Editorial communications should be addressed to C. A. Chant, University of Toronto, Toronto, Ont.

Business correspondence, remittances, etc., should be addressed to Chas. P. Sparling, Treasurer of the Society, 198 College Street, Toronto.

Communications regarding Library matters should be addressed to the Librarian.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the *Journal* is included in membership fee.

Anyone wishing to purchase a telescope may correspond with the Secretary, Toronto.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

OFFICERS FOR 1915

Honorary President—W. F. KING, C.M.G., LL.D., Chief Astronomer, Ottawa
President—J. S. PLASKETT, B.A., D.Sc., Ottawa.
First Vice-President—A. D. WATSON, M.D.
Second Vice-President—A. F. MILLER.
Secretary—J. R. COLLINS. *Treasurer*—CHAS. P. SPARLING.
Recorder—W. E. JACKSON, M.A., *Librarian*—H. B. COLLIER, Phm.B.
Curator—ROBERT S. DUNCAN.

Council—The above Officers, and the following members:—Rev. I. J. KAVANAGH, M.A., D.Sc., S. J., Montreal; Rev. Dr. MARSH, F.R.A.S., Holstein; STUART STRATHY, Toronto; Sir JOSEPH POPE, K.C., M.G., Ottawa; OTTO KLOTZ, LL.D., F.R.A.S. Ottawa; Dr. W. M. WUNDER, Toronto; and Past Presidents ANDREW ELVINS, JOHN A. PATERSON, K.C., M.A.; R. F. STUPART, F.R.S.C.; Professor C. A. CHANT, W. BALFOUR MUSSON, Professor A. T. DELURY, Professor LOUIS B. STEWART; and the presiding officer of each Centre as follows: F. A. MCDIARMID, B.A.; W. A. LOGAN, C.E.; WM. BRUCE, J.P.; JAMES DUFF, M.A.; C. E. BASTIN, B.A.; Professor W. H. DAY, B.A.; and A. W. MCCURDY.

OTTAWA CENTRE

President—F. A. MCDIARMID, B.A. *Vice-President*—J. J. MCARTHUR.
Secretary—R. E. DELURY. *Treasurer*—D. B. NUGENT.
Council—R. M. MOTHERWELL, W. M. TOBEY, DR. R. K. YOUNG.

PETERBOROUGH CENTRE

Local President—W. A. LOGAN, C.E. *Vice-President*—C. FESSENDEN, M.A.
Secretary-Treasurer—S. J. KEYES, B.A.
Council—W. I. CHISHOLM, M.A.; H. O. FISK, C.E.; T. C. ELLIOT; DUNCAN WALKER, B.A.; D. E. EASSON, B.A.Sc.; HENRY CARVETH.

HAMILTON CENTRE

Local President—WM. BRUCE, J.P. *1st Vice-President*—W. A. ROBINSON.
2nd Vice-President—REV. I. J. MORTON. *3rd Vice-President*—EDGAR SCHOLES
Secretary—T. H. WINGHAM, B.A. Sc. *Treasurer*—SENECA JONES.
Council—MISS I. M. WALKER, J. F. HARPER, MRS. J. F. HARPER, J. J. EVEL, J. M. WILLIAMS.

REGINA CENTRE

Hon. President—DR. R. A. WILSON, M.A.
Hon. Vice-President—N. MACMURCHY, B.A.
President—JAS. DUFF, M.A. *Vice-President*—W. G. SCRIMGEOUR, M.A.
Secretary-Treasurer—ALFRED J. PYKE. *Auditor*—J. E. CAMPBELL, B.A.
Council—WM. TRANT, P.M.; H. S. MACCLUNG, E. MURRAY, C.E.; Miss E. D. CATHRO, B.A.

WINNIPEG CENTRE

President—C. E. BASTIN, B.A. *Vice-President*—J. H. KOLB.
Secretary-Treasurer—H. R. KINGSTON, M.A., Ph.D.
Council—REV. FATHER J. BLAIN, S.J.; PROFESSOR NEIL B. MACLEAN, M.A.; PROFESSOR L. A. H. WARREN, M.A., PH.D., F.R.A.S.; F. POWELL.

GUELPH CENTRE

Honorary President—HENRY WESTOBY, ESQ.
Honorary Vice-President—JAS. DAVISON, B.A.
President—PROFESSOR W. H. DAY, M.A.
First Vice-President—DR. H. G. ROBERTS.
Second Vice-President—H. J. B. LEADLAY.
Secretary-Treasurer—PROFESSOR R. R. GRAHAM, B.A., B.S.A.
Recorder—J. S. LUTON, M.A.
Council—MRS. J. J. DREW, MISS MARY MILLS, J. MCNIECE, B.A.; F. A. GRAESSER, H. E. S. ASBURY, COLONEL D. MCCREA, and ALD. H. MAHONEY.

VICTORIA CENTRE

Honorary President—DR. YOUNG, Minister of Education.
President—A. W. MCCURDY. *Vice-President*—E. H. COTTERELL, C.E.
Honorary Secretary-Treasurer—L. T. HOUGHTON, M.D.
Executive Committee—G. G. AITKEN, W. S. DREWRY, C.E.; I. W. LETHABY, L.L.B.; F. C. SWANNELL, B.C.L.S.; J. E. UNBACH, G. GRAY DONALD, C.E.; AUGUSTINE SYMONDS.

THE JOURNAL
OF THE
ROYAL ASTRONOMICAL SOCIETY
OF CANADA

VOL. IX. FEBRUARY, 1915. No. 2

THE SIDEREAL UNIVERSE

BY J. S. PLASKETT

(PRESIDENT'S ADDRESS, ANNUAL MEETING, JANUARY 12, 1915.)

THE subject I have chosen for the Annual Address to the Royal Astronomical Society is a very wide one, wider perhaps than any other possible subject. It is, of course, impossible in a single address to treat such a subject at all adequately and I consequently propose to confine myself to some aspects of the constitution and nature of the universe which seemed to me most likely to prove interesting on this occasion, and which at the same time will give a fair idea of some of the most recent advances in this domain of science.

The determination of the constitution, the structure and the motions of the universe is the ultimate aim of all astronomical research, and is hence a peculiarly appropriate subject for the Annual Meeting of our Society. It may be pointed out, however, that not only astronomy but nearly all other sciences are concerned directly and indirectly in the investigation of this complex and difficult problem. Indeed, one of the most striking characteristics of present day science is the intimate relation and

co-ordination, which is every day becoming more and more marked, between the various branches of science. Some of these relations will be evident as we proceed.

It is undoubtedly true that the last ten or fifteen years have seen a greater development of our ideas and the growth of a more precise knowledge of the universe, especially with reference to the constitutions, motions and arrangements of the stars, than all previous time. Such a development with regard to their positions and motions, at any rate, has only been rendered possible by the labors of the early astronomers who painstakingly and accurately, and with a knowledge that they could never see the full fruits of their labors, mapped the positions of the stars. They thus enabled, by the comparison of these positions with those of the present, an accurate determination of their proper motions, their change of position in the sky. The name of Boss, to whose genius and painstaking the cataloguing of the proper motions of the brighter stars is due, is intimately connected with this part of the data on which generalizations as to the structure of the universe is based.

Of almost equal importance with the proper or cross motions of the stars in the solution of this problem, is their velocity in the radius vector, in the line of sight, towards or from us. Unlike proper motions, which for accurate values require long separated observations of the positions of the stars, a single observation by the spectroscope gives the radial velocity. The main work of the Lick Observatory for the past fifteen years has been the determination of the radial velocities of the brighter stars, and the name of Campbell will always be associated with this important work. Within the last three years, the radial velocities of some 1500 stars, the great majority of which have been determined at Lick, have been published by him.

It is evident, however, that one other factor is necessary to determine the complete motion and position of the stars and this is their distance. The determination of th parallax, the angle subtended at the star by the distance between the earth and the sun, from which the linear distance is readily determined, is one

of the most difficult and exacting of all astronomical measurements. This is owing to the enormous distances and correspondingly small angles to be observed, the greatest angle involved (that from the nearest star α Centauri) being equal to the angle between two points a quarter of an inch apart at the distance of a mile. The relative errors in these measurements are therefore much greater than in the other two factors. Numerous astronomers have been engaged for some years in this work and the sum of their endeavors is that the parallax or distance of about 350 stars has been determined with fairly satisfactory precision. This number has been considerably added to by indirect methods but undoubtedly the greatest need to-day is a reasonably accurate determination of the distance of many more stars.

After the determination of these fundamental factors of the stars' positions and motions, the work of calculation and generalization begins, and to this many investigators of the first rank have given their labors. Foremost among these must probably be placed Kapteyn who by his statistical studies has led the way to many important results. But Dyson, Eddington, Campbell, Russell, Schwarzschild and others have by their labors on the structure and motions of the universe added markedly to our knowledge.

Before summarizing the most important results of these investigations and generalizations concerning the geometrical and dynamical relations in the universe, it will be desirable to devote some time to the consideration of the physical nature and constitution of its individual members; especially as the two branches, the astrometrical and the astrophysical, are intimately associated. The same instrument, the spectroscope, which tells us the velocity of approach or recession of the heavenly bodies, also gives us exact and certain information as to their constitution and physical condition. This marvellous instrument, probably the most potent factor in unravelling the mystery of the universe ever discovered, tells us equally well for the nearest or most distant celestial objects, provided only sufficient light is available, and by the analysis, in an instant as it were, of the inherent

character of this light, the radial velocity, the chemical constitution and the physical condition of their outer radiating surfaces.

Just as the name of Campbell is connected with the determination of the radial velocities, so is the name of Pickering, doing at the same time full justice to the pioneer researches of Huggins and Vogel, associated with the determination of the constitution of the heavenly bodies and the classification of their spectra into well defined types. The researches at the Harvard Observatory on the spectra of the stars have been made with the objective prism spectroscope which, unlike the slit spectroscope used in radial velocity determinations, with which the spectrum of only one star can be photographed at a time, enables some hundreds of spectra to be photographed on a single plate. Over one hundred thousand stellar spectra have thereby been obtained. The discussion of this vast quantity of material has resulted in a system of classification by which more than ninety-nine per cent. of the spectra can be arranged in six main types or groups which have been designated by the letters *B*, *A*, *F*, *G*, *K*, *M*.

In order that what is to follow may be more readily understood by those not familiar with stellar spectra it is desirable to describe briefly the various types of spectra. In the first place the great majority of these spectra are crossed by dark lines, and are absorption spectra; this indicates the important fact that the stars in general are incandescent glowing bodies whose outer and less dense atmospheres are at lower temperatures than the interior and produce these absorption lines in the spectra. Even if nothing more than this were determined by the spectroscope it would be a conclusion of great importance. In addition to this, as is well known, the positions of these lines, by comparison with the spectra of the terrestrial elements, enable identifications of the elements present in the atmospheres of the stars to be made. Comparing the different types in this way, we find that they are arranged in an orderly sequence, the *B* type having comparatively simple spectra with few lines, mostly corresponding to the elements helium and hydrogen. In the *A* stars helium dis-

appears and we have hydrogen and a few of the metals. In the succeeding types the metallic lines become stronger and more numerous, more and more metals being represented, and the relative intensity of the hydrogen decreases. At the same time, while the *B* and *A* stars are intensely white or bluish white, the succeeding types become yellowish, yellow-orange and red. As examples we have Rigel, of the *B*; Vega or Sirius, *A*; Procyon, *F*; Capella and the sun, *G*; Arcturus, *K*; Betelgeuse or Antares, *M*. Notwithstanding the very varied constituents represented in the atmospheres of these different types, astronomers have unanimously, and from various considerations into which I cannot enter, reached two conclusions which are indeed generalizations of very fundamental importance. The first is that all the heavenly bodies, nebulæ, stars, planets and satellites are of the same constitution, composed of the terrestrial elements, or to be more precise, possibly in some cases, of the substances from which the terrestrial elements have developed. Shortly stated — all are agreed on the fundamental unity of the cosmos. The second conclusion is that the marked differences in the spectra of different types are produced only, or at least mainly, by differences of temperature. From the distribution of spectral intensity in these various types, (a rough indication being also given by their colors), the probable temperatures of the radiating atmospheres of the stars have been determined ranging from about 3000°C. (5400°F.) in the *M* stars, to about 20000°C. (36000°F.) in the *B* types. Our sun, of the *G* type, is at a temperature of about 5000°C. (9000°F.).

Furthermore, astronomers are generally agreed that the fundamental cause of the great differences in temperature indicated and the enormously high temperatures reached can be ascribed to the condensation, under the action of gravitational force, of the gases of which these bodies are composed. Starting with the primordial substance of gaseous or other character present in the nebulæ whose particles attract one another and hence, by the principle of the conservation of energy, producing heat and increasing the temperature, the process of this evolu-

tion has been traced in an orderly fashion through the various types, but in two different methods, resulting in two distinct theories on the order of stellar evolution.

It will be of great interest first of all to sketch briefly the main features of these two theories and then to adduce the latest evidence leading to the support of each. To do this will not only clarify our ideas about the constitution and development of the stars but it will also lead (and this is the main object of this paper) to statements of the recent advances in our ideas, not only of the constitution, form and structure of the universe, but of the ultimate constitution of matter.

The idea of the evolution of the stars most generally accepted by astronomers is that the nebulous material whether gaseous or pulverulent, condenses under the self attraction of its matter, rises in temperature, getting hotter and hotter, until it forms the *B* and *A* type stars of very high temperatures and low density, the early type stars as they are generally called, in which the principal elements showing in the outer atmospheres are the light gases, hydrogen and helium. The enormous radiation into space, combined with the slowing rate of condensation as the density increases, causes a gradual lowering of the temperature, the disappearance of the lines of helium, the appearance of more and more metallic lines and the change of type through *F*, *G*, and *K* into the *M* type stars, where the banded appearance due to chemical compounds appears. These bands evidently can only appear when the temperature becomes sufficiently low to allow their formation. The fall of temperature is indicated further by the changing colors from blue and white to yellow, orange and red. After the *M* type is reached the fall of temperature is rapid, the loss of light even more rapid, and the star soon becomes invisible.

The other idea of the evolution of the stars which postulates stars and spectral types on both the ascending and descending scale of temperature was primarily due to Sir Norman Lockyer many years ago. A modified form of this hypothesis has been quite recently advanced by Russell and vigorously supported by

considerations adduced from the latest additions to our knowledge of the universe. Briefly, Russell believes in the same primordial matter, the condensation and rise of temperature as before, but he claims that as the nebula condenses and becomes hotter we have visible stars formed first of the low temperature, red, *M* type stars. Increasing temperatures causes these to pass through all the spectral types, *K*, *G*, *F*, to *A* and *B*. Afterwards they again pass through the same stages in the reverse order on the descending scale of temperature in exactly the same way as postulated by the other theory. Thus all the stars pass through the yellow and red stages twice, once when the temperature is rising and once when falling. In the former state it is evident that the stars will be much less dense and therefore of much greater diameter and consequently brighter. Hence, if it can be shown that there are red type stars both of less and greater density than the white stars, it will form a strong argument in favor of the theory.

Much can be said for and against each theory of stellar evolution and it is not possible to tell which is nearer the truth. I will try and state briefly the case for each, and bring forward the most recent information in my knowledge in support.

It has been generally believed that the order of evolution postulated in the first theory was the correct one on account of the close analogy and similarity between the spectra of the gaseous nebulæ and the *B* type stars. The nebulæ contain, besides the lines of hydrogen and helium present in the *B* stars, lines of an unknown element called nebulium.

It is possible to trace an orderly development from the spectra of the gaseous nebulæ to the *B* stars through some intermediate types or sub-types of spectra called in the Harvard classification the *O* type, and also in a few very distant and faint stars called the Wolf-Rayet stars. The gaseous nebulæ give bright line spectra, and we see the gradual fading out and replacing of the bright lines by absorption lines in passing from the nebulæ through the *O* types and Wolf-Rayet stars to the *B* type, and the same progression in the number and character of the

lines as occurs in the evolution from *B* and *A* to the yellow and red stars. So that we can trace in a consecutive and apparently continuous course the evolution from the nebulæ through the *O* to *B*, *A*, *F*, *G*, *K* and *M* types without any apparent gap left between the nebulæ and the *O* and *B* in which we could insert the red and yellow types, low temperature, low density stars required by the second hypothesis.

This consideration has moreover been strengthened very materially by the work done within the last year or so by Nicholson, a mathematical physicist of the University of London. The physicists, as you know, within the last few years have been upsetting our ideas about the atom as being the ultimate division of matter, have been, indeed, introducing astronomical ideas into its constitution, the most recent idea, perhaps I would be safer in saying one of the most recent ideas, being that the atom is a sort of solar system, as it were, having as its central sun a nucleus of a positive charge of electricity the planets being negative electrons revolving around it ; the infinitely small and the infinitely great being here brought into close analogy.

Three years ago Nicholson published a remarkable mathematical investigation on the spectra of the nebulæ, especially on the lines given by the hypothetical element nebuluim which has no known terrestrial analogue. By assuming the atom of nebuluim to be composed of a positive charge with four negative electrons revolving around it, he was able to show that the oscillations of this system under ordinary dynamical laws would give spectral lines in the positions of the principal nebulium lines, thus indicating that the atom of nebuluim is of a very simple structure. Three or four other papers along allied lines have been published by him within the last year, which have a special bearing on our theories of evolution. Briefly speaking, he has built up a very striking and beautiful theory of the evolution of the elements and illustrated and confirmed it by computing the wave lengths of the principal lines in the nebulæ and early type stars, and these computed values are in very close agreement with the observed positions.

Assuming the form of the primary atom to be a simple ring system with a nucleus of one positive charge + e and one negative electron, computation shows that the oscillations of this system will set up a vibration in the ether giving the wave-length λ1823·55. This wave-length is almost exactly half of λ3647·14, the observed wave-length of the limit of the principal Balmer series of hydrogen lines. This he calls proto-hydrogen, in analogy with Lockyer's nomenclature, and states that it must be presumed to be a constituent of nebulæ although, owing to the absorption of our atmosphere, it can never be observed. The first evolution product of this atom is hydrogen.

The simple ring atom with a nucleus of a positive charge of $2e$ and 2 electrons gives lines strongly present in nebulæ, which were also very strong in Nova Persei. The chief line is 3868·88.

The atom with nucleus + $3e$ and 3 electrons gives lines present, though not so strongly in the nebulæ. The chief line is λ5187.

Nebulium is the simple ring atom with nucleus + $4e$ and 4 electrons giving among others the strongest nebular lines 5006·89 and 4363·5. The unknown lines in the Wolf-Rayet spectrum can be readily obtained from nebulium. Nicholson says that they are the leading members of a set of series analogous to Balmer's *H* series but containing different constants, calculable from the properties of the atom of nebulium.

The simple ring atom with nucleus + $5e$ and 5 electrons gives the main lines in the solar corona and Nicholson calls this proto-fluorine.

The atom with nucleus + $6e$ and 6 electrons gives the lines 3484·7 and 3111·4. The first coincides almost precisely with the strong ultra violet radiation recently found by Max Wolf in the Wolf-Rayet stars, while the second can not be observed. If this atom loses two of its electrons its vibrations will produce the lines λ3729 and 4068·8 so prominent in the nebular spectrum.

The calculation of the atomic weights of these atoms, according to Nicholson, gives

For atom of nucleus + $2e$ = ·3275
$4e$ = 1·31 nebulium
$5e$ = 2·05 proto-fluorine
$6e$ = 3·95 archonium

This has been corroborated by an experimental research of Fabry, Buisson and Bourget, who showed that a substance giving the nebular line λ3729 should have an atomic weight of nearly 3.

Nicholson does not consider these simple ring systems as elements but rather as origins from which elements may spring. He thinks that these atoms differ from the atoms of terrestrial substances principally in the nucleus, which in the latter consists not of a simple positive charge but of a complicated system of positive and negative charges packed together, and he regards matter in its nebular beginnings as being in a different state from its ultimate form in terrestrial elements.

These investigations show very clearly the analogy, mathematically computed, between the gaseous and planetary nebulæ and the Wolf-Rayet stars. This theory has been most strikingly corroborated experimentally by some recent work of Wright, published only within the past month in the last issue of the *Astrophysical Journal*. He has observed the spectra of the nucleus of the planetary nebulæ *N. G. C.* 6572 and found it contains a number of the Wolf-Rayet lines. Conversely, observing the gaseous envelope, discovered by Campbell, surrounding the Wolf-Rayet star *B. D.* + 30°3639 and which the latter found was composed of hydrogen, Wright finds in addition to emission due to hydrogen, the lines of a planetary nebula, and concludes hence that the nuclei of planetary nebulæ are Wolf-Rayet stars.

Some years ago Pickering announced that a series of lines of unknown origin discovered in the *O* type star ζ Puppis, was probably another series of hydrogen similar to Balmer's series, though these lines had never been seen in the laboratory spectrum of hydrogen. About two years ago Fowler, who had previously

reproduced the spectra of comets in a vacuum tube, obtained this series of lines and the line or band 4686, also very prominent in early type stars, in a tube containing helium with hydrogen impurity.

Shortly afterwards Bohr, who has brought forward another very interesting theory of atomic structure, differing from Nicholson's, in considering the vibrations as being produced under laws different from those of ordinary dynamics, stated that this series and λ4686 were due to the helium atom postulated as having a nucleus of positive charge $2e$ and only one electron.

The question between Nicholson and Bohr as to the constitution of the atom can not be regarded as settled, although Nicholson appears to have the last word. There results, however, from these considerations a very definite relation and connection between the spectra of the gaseous and planetary nebulæ, the Wolf-Rayet stars, the Novæ and the early type stars of the groups *O* and *B*, which seems to be very well established, and forms a strong argument in favor of the first theory of stellar evolution, namely, that the *O* and *B* stars are the direct product of the condensation of the gaseous nebulæ without intermediate stages of red and yellow stars.

I can not do better in presenting the case for the other theory of stellar evolution, which postulates stars on both ascending and descending temperature scales, than to follow Russell, not only the founder in the present form but its able and persistent advocate.

Russell follows the spectral nomenclature introduced at Harvard, and shows first of all by the differences in the color indices (the color index of any star being the difference between the visual and photographic magnitudes and evidently a function of the spectral type), how well the divisions in the spectral scale, though produced somewhat empirically at Harvard, have been placed. This is also indicated by the stellar temperatures corresponding to each division.

He tabulates the available information in regard to the relation between the spectral classes of the stars and their color

indices and temperatures, their numbers, their parallaxes, and their mean peculiar motions. These appear herewith.

Spect.	Color Index			Temperature	Counts		Mean Parallax 5th Mag	Peculiar Motion	
	King	Parkhurst	Schwarzschild		Number above 6·25 Mag.	-°/₀ in Galactic Region	Boss	Campbell	Boss
				°C.			"		
O					30	100	0·004		
B	-0·32			20000	696	82	·007	6·5	6·3
A	0·00	0·00	0·00	11000	1885	66	·010	10·5	10·2
F	0·30	0·43	0·40	7500	720	57	·012	14·4	16·2
G	0·71	0·86	0·84	5000	609	58	·008	15·9	18·6
K	1·16	1·30	1·35	4200	1719	56	·010	16·8	15·1
M	1·62	1·68		3100	457	54	·008	17·1	17·1
							Kapteyn		
N		2·5		2300	8	87	·000		

Some of the figures do not afford any evidence in favor of the second theory, but rather on the contrary, if the age of a star has any influence on its velocity, then the peculiar motions show that the *B* and *A* stars are of the earliest types.

At the same time the recent work at Lick on the radial velocities of the planetary nebulæ, which are in the mean greater than 40 km. per second, seems to be decidedly against the theory that the *O* and *B* stars, whose velocities are small, have developed directly from the planetary nebulæ.

However, Russell lays the greatest stress on the relation between the spectral type and the absolute brightness or magnitude of the stars, which had previously been discussed by Kapteyn, Herzsprung and others.

It is evident that stars can only be compared for absolute or intrinsic brightness, when their distance is known; and unfortunately, owing to the very great distance of most of the stars, only comparatively few have had their parallax or distance measured with reasonable accuracy. Kapteyn defines the absolute magnitude of a star as the magnitude it would have if placed at a distance whose parallax was 0″·1, equivalent to 32·6 light years. At this distance, another name being 10 parsecs (10 times the distance for a parallax of 1 second), our sun would appear as a

star of about 4·7 magnitude, this being hence its absolute magnitude. Russell has compiled the fairly reliable direct measures of parallax, about 300 in number, and those which can be determined from their positions in moving clusters, about 150 in number, a total of about 450 stars. From these parallaxes the absolute magnitudes are readily derived when the observed magnitudes are known. These have been plotted graphically in relation to the spectral types, and some very remarkable results obtained. The total range of absolute luminosity or brightness of the stars is enormous, as they range from stars about 3000 times as bright as the sun to those only about $\frac{1}{6000}$ as bright.

The results obtained from a study of these graphs may be stated as follows:— In the first place all the white stars, those of *B* and *A* types, are bright, of the order of about 100 times the sun's brightness. Second, all the very faint stars whose brightness is less than $\frac{1}{50}$ that of the sun, are red stars of types *K* and *M*. Third, the absolute brightness of the spectral classes decreases as we proceed from *B* to *M* from white to red stars, those of the same type *G* as the sun being of about the same brightness. Fourth, besides this gradual decrease in brightness there are a number of stars in each spectral class very bright, averaging about 100 times the brightness of the sun. Examples are the red stars Aldebaran, Arcturus, Antares, the latter 2000 times as bright as the sun. Fifth, there is a certain limit of brightness for each spectral class below which stars of this class are very rare; each class varies over a range of about two magnitude and each class is about seven times brighter than the next redder class. Sixth, in the red stars of *K* and *M* types there are no stars of the same brightness as the sun, though there are many much brighter and many much fainter.

We may express this in another form by saying that there are two great classes of stars, the one of great brightness averaging about 100 times the sun and varying little from one class of spectrum to the other, the other of less brightness which falls off very rapidly with increasing redness. These two classes were

first noticed by Hertzsprung, who called them very fittingly Giant and Dwarf stars.

The question naturally arises what differences in nature, constitution or development, give rise to the differences in brightness between the giant and dwarf stars and why should these differences become more marked as the stars become redder.

We must not forget that we are now discussing the absolute magnitudes, the actual luminosities of the stars, their apparent brightness if all were placed at the same distance from us. It is evident that this must depend on the three factors, the mass, the density and the surface brightness. Large mass, small density (which, of course, gives large volume and surface area) and high surface brightness go to produce giant stars which will appear when one or more of these attributes are present, while the dwarfs occur when the opposite attributes preponderate.

What information has been collected as to the masses, densities and surface brightnesses of the stars? For this we are mostly indebted to data obtained from visual and spectroscopic binaries for the masses; from eclipsing variables for the densities; and to spectro-photometric investigations for the relative surface brightness of the different spectral classes. From these data we find that although we have a known range in the absolute magnitude of a million-fold, and in the densities of about the same amount, the range in masses, so far as known, does not exceed fifty fold. At the same time there is some evidence of a relation between mass and luminosity. For example those stars known to be of small mass are in general fainter than the sun, while the stars of class *B*, which are all very bright, are on the average of ten times greater mass than the sun.

The study by Russell of 87 eclipsing variables led to some very striking and interesting results in regard to the densities of these stars which may be taken, probably without serious error, as typical of the densities of the stars generally. The stars of classes *B* and *A* are approximately similar in density, ranging from about $\frac{1}{3}$ to $\frac{1}{40}$ of the sun's density. On the other hand the densities of stars of the classes *G* and *K* vary enormously, rang-

ing from *W* Ursæ Majoris, nearly twice as dense as the sun, to *W* Crucis, about one-millionth the sun. We have here then the explanation of the enormously different brightness of the giant and dwarf stars of classes *K* and *M*. We know that the surface brightnesses are approximately the same and that the masses are of the same order, hence the difference must lie in the densities, and this we have seen is possible from the examples above. If we take the typical giant star of class *M* which averages about 1000 times as bright as the dwarf of the same class and assume the mass and surface brightness the same, the giant will be only $\frac{1}{1000}$ as dense as the dwarf.

Russell summarises the facts which he has collected and which appear to be well substantiated as follows:

1. The differences in brightness between the stars of different spectral classes and between the giant and dwarf stars of the same class do not arise (directly at least) from differences in mass. Indeed the mean masses of the various groups of stars are extraordinarily similar.

2. The surface brightness of the stars diminishes rapidly with increasing redness, changing by about 3 times the difference in color index or rather more than one magnitude from each class to the next.

3. The mean density of the stars of classes *A* and *B* is a little more than one-tenth that of the sun. The densities of the dwarf stars increase with increasing redness from this value through that of the sun (1·44), to a limit which cannot at present be exactly defined. This increase in density, together with the diminution in surface brightness, accounts for the rapid fall in absolute or intrinsic luminosity (about sevenfold from one spectral type to the next) with increasing redness in these stars.

4. The mean densities of the giant stars diminish rapidly with increasing redness, from one-tenth that of the sun in class *A* to less than one twenty-thousandth that of the sun for class *M*. This counteracts the change in surface brightness and

explains the approximate equality in luminosity of all these stars.

5. The actual existence of stars of spectra *G* and *K*, whose densities are of the order here derived, is proved by several examples among the eclipsing variables — all of which are far less dense than any one of the more numerous eclipsing stars of "early" type, with the sole exception of β Lyræ.

A little consideration enables us to see that these facts deduced by Russell from reliable data and which, so far as I know, are incontrovertible, form very strong evidence for the second theory of stellar evolution. In no other way than by a scale of ascending and descending temperatures can the presence of giant and dwarf stars of red type *K* and *M* be explained. This may, perhaps, best be seen by tracing the evolution of a star from the nebulæ according to the second hypothesis. As the condensation of the nebula, which we may suppose extraordinarily extended, of a very low density, lower than we can obtain in the highest vacuum and at a low temperature, proceeds, we have the volume diminishing, the density and temperature increasing until the star becomes visible, a very red type *M* star of low density of the order of $\frac{1}{25000}$ of the sun, a giant star of *M* type. As condensation proceeds, the volume continues to diminish, the density and temperature to increase, the loss in surface area being about compensated by the increase in surface brightness. Thus we have giant stars of types *K*, *G*, *F*, *A* and *B* produced, the density temperature and surface brightness increasing rapidly. For example, from *M* to *B* the density has increased from about $\frac{1}{25000}$ to $\frac{1}{10}$ the sun, and the temperature has risen from about 3000° to 20000°C. But condensation still proceeds, though not so rapidly, and the loss by radiation begins to overpower the gain of energy by condensation. The temperature begins to fall and the star now proceeds in the reverse order, back through *A* to *M*. But in this stage the density is increasing and both volume and surface brightness diminishing and hence the absolute magnitude diminishes rapidly, exactly as shown by Russell, and we have the

dwarf stars of the later types. After passing through the *M* stage the star soon becomes invisible.

This is the development followed by the more massive stars. Stars of less mass do not reach so high a temperature and do not get beyond the *A* type or even the *F* or *G*, while bodies of mass less than $\frac{1}{10}$ the sun may not become visible at all. This also is very clearly shown by the data collected by Russell, who shows that the *B* type stars on the average have about ten times the mass of the sun and are all giants.

It will thus be seen that many arguments may be adduced in favor of both theories and it is possible, of course, that both may be true. A number of questions may be asked which are difficult to answer from either theory. For example, in the first theory, how can the great gap in temperature between the nebulæ, presumably not far from absolute zero, and the *B* stars, at 20000°C, be accounted for? Surely this difference in temperature cannot be bridged without some visible evidence appearing in the universe. Again, in the second theory, what becomes of the nebulium, helium and hydrogen shown in the gaseous and planetary nebulæ and so prominent in their spectra, if the next stage is a late *M* star with no evidence of the first two substances, hydrogen relatively very weak, and myriads of metallic lines?

I will put one more question and then pass on to a brief summary of recent additions to our knowledge of the structure of the universe. Is it not possible that the order of procedure of development is different, depending on the character of the nebulous material? The relation between the gaseous and planetary nebulæ and the apparently continuous development to Wolf-Rayet *O* and *B* type stars has been shown by the work of Nicholson and Wright already reviewed. But the great majority of the visible nebulæ in the sky do not give a gaseous spectrum, but apparently give a continuous spectrum, or one of some similarity to the sun. May not the order of development from these nebulæ or from those which are quite invisible to us follow the lines laid down by Russell?

There are many other interesting and fruitful lines of inves-

tigation concerning the structure and motions of the universe along which marked progress has recently been made, but time will not permit me to more than briefly touch upon some of them.

One of the most important of these is the question of the absorption of light in space, for evidently upon it will depend our measures of the extent of the universe. If there is an absorption of the light in coming from the distant stars, then our statistical calculations based on the numbers and relative distances of stars of different magnitudes will be in error, and our visible universe will be smaller in extent than we had supposed.

The question of this absorption has been attacked from many sides by different investigators and the general conclusion seems to be that there is an absorption due possibly to the presence of invisible nebulous matter, but that this absorption is very small and will only have an appreciable effect on the magnitudes of stars at distances of some thousands of light years.

The question of the extent of our universe and its general form and dimensions has been attacked within the past year by three investigators, using different material. Walkley, in a paper before the Royal Astronomical Society, from data obtained principally from the *B* type stars, shows that our sun is not central with respect to the galactic plane, that it is situated about 2° to the north of this plane and that it is nearest to the portion in which Cygnus is situated, being distant from the boundary about 5000 light years in this direction and about 6000 towards Argo. Russell and Shapley in the December number of the *Astrophysical Journal*, as a result of a study of the distribution of the eclipsing variables, have found that a considerable majority of these objects (almost all those of short period) lie within a region bounded by two planes 1000 light years apart and parallel to the galactic equator whose median plane passes 100 light years south of the sun, the latter in exceedingly close agreement with Walkley, whose figures given above make it about 130 light years. Almost all the remainder of these stars lie within 500 light years on each side of this region. Within this region the stars extend

in all directions to the limit of investigation. If space is transparent this limit is 8000 light years. A plausible amount of absorption cuts this down to about 4000 light years.

Dyson has investigated the distribution of the stars contained in Carrington's Circumpolar Catalogue and finds:

1. Yellow stars are the nearest to us, 80 per cent. of them being between about 300 and 1600 light years, 10 per cent. being nearer than 300 and 10 per cent. further away than 1600.

2. As we go from the yellow to the blue stars, or the orange and red stars, the distance increases.

3. The red stars are at great distances averaging over 3000 light years.

4. The stars vary greatly in intrinsic brightness, the red stars being especially luminous and averaging 100 times as bright as the sun.

5. Of all the stars down to the eleventh magnitude about 95 per cent. are more luminous than the sun.

6. When the luminosity of the stars in a given volume of space is considered, there are far more faint than bright stars.

7. Evidence has been found that the stars thin out very materially at great distances from the sun.

The general agreement between these and Russell's conclusions about the absolute magnitudes of the stars is very good, and indeed, the agreement between the three determinations of the dimensions and form of our sidereal universe is remarkable. They point to the universe as having a diameter of from 10000 to 15000 light years, a thickness of some 2000 to 3000 and with our sun not quite central in it.

Not much additional data in regard to the motions of the stars in this universe has lately appeared. The two-stream hypothesis, supported by Kapteyn, Eddington and Dyson, seems to be fairly well substantiated and may be plausibly explained on the supposition that our universe is composed of two separate systems interpenetrating one another. Quite recently Turner

has brought forward the suggestion that the two-drift system may be explained by orbital motions of the stars in the universe, those on one side of the centre appearing to have a preponderance of motion in one direction as those on the other side would have in the opposite direction. In this connection Jeans has computed that the directions of the stars in an orbital motion of this character would not be appreciably deviated by the approaches of neighboring stars. The probable deflection of the path of a star due to encounters is only about 1° after three thousand million years.

That there may be other systems besides our own universe is suggested by Herzsprung, who finds a distance of 30000 light years for the small Magellanic Cloud if space is transparent. If at this distance it would be about a thousand light years in diameter and evidently a small affair as compared with our own universe.

The Andromeda Nebula gives a solar type spectrum and if a star cloud, must be at the same order of distance. The very high velocity found by Slipher, three hundred kilometres per second approach, is considerably higher than anything in our own system except two or three isolated stars, while he further states that some of the other spirals have even higher velocities.

It will be seen that many wonderful avenues of research are being opened up and new view-points concerning the universe are being suggested by these recent developments in astronomy and allied sciences. But all these investigations point to the great need of yet more and more information as to the motions and distances of the stars.

It is now fairly well known exactly what information is needed to most usefully further these various lines of research, and it is the province of astronomers to furnish this data as soon as possible. The new telescope that our country is installing should be able to take an important part in supplying this information and should materially help in the solution of the fundamental problem of astronomy, the constitution, structure and motions of the universe.

THE CLAIMS OF METEORIC ASTRONOMY

By W. F. Denning

IT is singular that in the field of meteoric astronomy there are so very few enthusiastic observers; yet it freely offers attractive spectacles and important discoveries. The photography of meteors, in an ample and effective manner, has failed and mathematicians are disposed to look lightly upon the rather inexact and doubtfully accurate eye estimates of position upon which we necessarily have to depend. Observers avoid this branch owing to its uncertainties and its main requirements—very patient and prolonged observation. They prefer to go out and find their subject for study steadily before them, be it moon, planet or star and seldom care to wait in the cold for fleeing objects leaving only momentary impressions of their places and durations.

But it is wonderful, I think, how correct a good observer may become in tracing meteor-flights. He may certainly determine the central point of a radiant within one degree or often less. This is sufficiently accurate for all practical purposes. But meteoric observers of exceptional skill are, like real poets, born not made. Having had considerable experience in comparing results and in reducing the records of various observers I have no hesitation in saying that some of them have lacked the necessary aptitude and faculty for this work and that the error in the positions of radiant points amounted to between 4 and 8 degrees. On the other hand a few, in fact a very few, possessing the special faculty for this class of observation have acquired a degree of exactness far beyond what would have been considered possible.

We want many observers capable of collecting materials more precisely and reliably than has ever been done in past years. Rough, inaccurate or imperfect data are useless as only

serving to complicate matters. And even the utility of good observations may be vitiated if they are not reduced in a sound manner.

There are some undiscovered details still awaiting detection by future observers in this department and some questionable features needing more extended investigation. There are some significant facts in the behavior of radiant points of which we require more evidence, the facts alluded to forming problems very difficult of solution. Corroborative testimony of a practical and extensive character is needed in order to remove scepticism which is quite natural and perhaps justified under all the circumstances. It is certain, however, that much of the scepticism is due to the difficulties in accounting for the alleged peculiarities, but could the objectors realize fully the striking evidence supporting them very little opposition would remain.

Meteoric astronomy offers many beautiful spectacles. I have occupied myself in several branches of observing but none has proved so entrancingly attractive as this. After nearly fifty years' vigils I find it now more intensely interesting than ever. The difficulties involved in the observations demand a keenness in effort which is always enjoyable.

A very small, short meteor, scarcely visible, calls forth the best powers of the observer and success in dealing with it enhances his satisfaction. A bright object is more readily and easily recorded but one on the borderland of visibility demands more skill. Many people go into raptures over a brilliant fireball and give a vivid description of it. But the tiniest meteor perceptible may have a more wonderfully suggestive story to tell. It is equally important if less imposing in a spectacular sense. The small unobtrusive objects should never be neglected. They often have a tell-tale significance.

The view of a beautiful meteor — and one comes pretty often to the patient watcher — encourages the observer and makes him enthusiastic. The outlook beyond the immediate work in hand gives the promise of significant discoveries clearing up old doubts and removing difficulties in a way to bring obser-

vation and theory into harmony and thus to place meteoric astronomy upon a better-assured basis.

There are many difficulties attached to meteoric investigation and I wish particularly to allude to one, and that is the determination of radiant points. Even when correct observations of a number of apparent paths of meteors have been taken it is a critical matter to ascertain their radiant points. The intersection of a 3 or 4 flights very frequently occurs as the result of pure chance. An observer must therefore have careful regard to the aspect of each meteor seen for there are family likenesses among the members of individual streams which materially help in sorting them out to their various systems. It is insufficient to rely simply upon the directions of the flights. The lengths of the paths, velocity, colors, etc., must all be considered. Past lists of radiants contain many false points introduced by the accidental intersection of the meteor flights. A meteor's backward line of motion may converge upon a dozen or more radiants and no observer, be he ever so experienced and skilled in the work, can always assign the correct position. This branch of meteoric reduction obviously requires the utmost discretion and very careful judgment.

In this paper I have only touched upon few points but hope that additional observers may be led to spend a little time in watching for meteors or shooting stars. These objects have a variety of names but some of them are not distinctive, and to obviate the use of compound words it seems almost preferable to adopt appellations something after the following, which I offer as mere suggestions.

Aerolite or Siderite	Geometeor or Terremeteor
Meteoric Fireball	Megameteor
Meteor 1st to 6th mag.	Meteor
Telescopic meteor	Telemeteor

I do not know whether a poetical allusion in regard to "Falling Stars" will pass the censor of your scientific JOURNAL but I have endeavored to express a few thoughts concerning them in verse.

FALLING STARS

Bright falling stars I greet you with a smile,
For you beguile,
My loneliness, with pleasure pure and sweet
In moment's fleet.
In colored beauty and in lustre dressed,
Never at rest,
You span the sky and gild the heav'nly way
With sparkling ray.
I only know the moments of your birth,
Above the earth ;
As she performs her yearly round in space
You run your race
And pierce the blue just as a flashing blade
To quickly fade.
Along your flight the burning embers sow
An after-glow,
To mark your path amid the stars of night,
With guiding light.
I never know the instant when you will
Disturb the still
Of Heaven's stars and speed athwart the sky
All silently.
Nor can I tell in Nature's open book,
Just where to look,
To watch your coruscations wax and fade
Amid night's shade.
Adown the east or west your fiery ball
May headlong fall,
Or, slowly, stream along the starry height
In graceful flight.
Whene'er you come you bring a joyous thrill
My soul to fill.
Oh messengers from distant worlds ! I yearn
Your tale to learn,
And I await, amid earth's frosted dews,
Celestial news.

November 27, 1914.

LARGE METEORS IN JUNE

By W. F. Denning

IN the Journal of the R. A. S. of Canada, September-October 1914, p. 372, Col. W. R. Winter, of Bermuda, calls attention to the abundance of large meteors visible in the last week of June this year. This accords with my own experience in England and evidence of it is furnished in my list of "Real Paths" published in the July-August number of this Journal where four large meteors are given for June 25.

The large meteor sketched by Col. Winter was probably directed from a radiant at 282° − 12° which was very active at midsummer this year and which I have also recognized in previous years both in June and July. Sometime ago I realized the probable importance of the period June 25-28 in a meteoric sense and carefully investigated my observations in order to discover whether any special shower displayed itself at this time. I found, however, traces of a large number of contributory streams rather than one of very pronounced richness. As other observers may like to watch at this congenial epoch in future years, it may possibly be useful to summarize the principa radiant points for reference :—

JUNE 25-28

24 + 43	238 + 47	282 − 12	314 + 47
30 + 36	245 + 64	284 − 22	320 + 11
40 + 56	260 − 24	291 + 52	320 + 21
43 + 37	261 − 12	293 + 10	334 + 28
48 + 44	261 + 4	294 + 40	335 + 58
161 + 58	263 + 63	304 + 23	342 + 39
193 + 57	270 + 30	305 − 12	352 + 39
213 + 53	270 + 47	314 + 61	354 + 77

There are many others, but I have selected for the above

list those which presented themselves most definitely and actively during my observations since 1876.

Records in December of this year (1914) show that two southern showers of very slow meteors have been visible at 336° − 12°, + 338° − 28°, December 8-15. These radiants are also very prominent in the summer and especially so at close of July and first half of August.

BRISTOL, ENGLAND.
December 19, 1914.

MEETINGS OF THE SOCIETY

ANNUAL MEETING

The General Annual Meeting of the Royal Astronomical Society of Canada was held in the Rooms, 198 College Street, Toronto, on the evening of January the 12th, 1915, First Vice-President, Dr. A. D. Watson, in the chair.

The Minutes of the Annual Meeting of 1914 as printed in the JOURNAL (January-February, 1914) were taken as read and approved.

The election of General Officers and Members of Council was then proceeded with. The scrutineers, Messrs. A. F. Hunter and H. J. Dingman, reported the result of the count of ballots and the following were declared elected for the year 1915:—

Honorary President—W. F. King, C.M.G., LL.D., Chief Astronomer, Ottawa.

President—J. S. Plaskett, B.A., D.Sc., Ottawa.

First Vice-President—A. D. Watson, M.D., Toronto.

Second Vice-President—A. F. Miller, Toronto.

Secretary—J. R. Collins, Toronto.

Treasurer—Chas. P. Sparling, Toronto.

Recorder—W. E. Jackson, M.A., Toronto.

Librarian—H. B. Collier, Toronto.

Curator—Robert S. Duncan, Toronto.

Council—Rev. I. J. Kavanagh, S.J., D.Sc., Montreal; Rev. Dr. Marsh, F.R.A.S., Holstein; Stuart Strathy, Toronto; Sir Joseph Pope, K.C.M.G., Ottawa; Otto Klotz, LL.D., F.R.A.S., Ottawa; Dr. W. M. Wunder, Toronto.

These, with the Past Presidents and the presiding officers of each Centre, constitute the General Council of the Society.

The General Secretary reported :—

Four General Council Meetings had been held during the year.

The number of meetings held during 1914 at the various Centres of the Society and the number of active members attached to each were reported as follows :

Toronto,	Number of	Meetings	held	16,	Membership		135
Ottawa,	"	"	"	13,	"		99
Hamilton,	"	"	"	7,	"		27
Guelph,	"	"	"	9,	"		36
Peterborough,	"	"	"		"		44
Winnipeg,	"	"	"	11,	"		18
Regina,	"	"	"	3,	"		15
Victoria, B.C.,	"	"	"	6,	"		101
							475
Honorary Members							23
							498

In order that uniformity might obtain in the subject matter of each report the following circular letter was forwarded to the Secretary of each Centre :—

Toronto, November 16, 1914.

As we are approaching the end of the year, I take the liberty of reminding you of the desirability of having the Annual Meeting of the Centre held at an early date.

In order that uniformity of method may prevail, it may not be amiss to indicate the nature of the report desired from the various Centres.

The Council of the Centre should hold its Annual Meeting in December, at which the report of the work at the Centre for the past year should be discussed and adopted.

The report should contain :

1st. The Local Treasurer's Report, giving a duly audited

detailed statement of the receipts and expenditures for the year.

2nd. A detailed statement of the estimated expenditure for the coming year and the amount of the "Grant" (if any) that will be required to carry on the work of the year.

3rd. A statement, prepared by the Local Secretary, giving the number of members in good standing, the number of meetings held, the attendance, the state of the work at the Centre, and any other matter of interest, or any suggestions that the Centre may desire to offer.

The above, as adopted on motion by your Annual Meeting, should be in the hands of the General Secretary and General Treasurer before December 31st, to be presented by them at the General Annual Meeting of the Society which takes place early in January.

The Secretary of each Centre has been requested to place the names of the Secretaries of the other Centres of the Society on the Mailing List for Notices of Meetings and Lectures in order to suggest themes for discussion and to stimulate a spirit of mutual interest throughout the entire Society.

The Reports received from the Centres are appended.

Dr. R. E. DeLury, Secretary of the Ottawa Centre, reported as follows:—

During the year thirteen regular meetings, one special meeting and an At-Home were held by the local Centre of the Society; ten in the spring term and five in the fall term. The At-Home, held on the evening of January 29th, consisted of a reception at the Observatory, illustrated demonstrations of the various lines of work of the Observatory and Surveys, and moving pictures taken on one of the Boundary Surveys in the Yukon; after which refreshments were served. About 160 guests were present. On the afternoon of March 20th, a special meeting was called to take advantage of Dr. J. A. Brashear's presence in the City. He gave a very interesting talk on S. P. Langley. The regular meetings of the Society were as follows:

EVENING MEETINGS, SPRING TERM

"The Work of the Dominion Observatory," (Two Lectures), Dr. W. F. King.

"How Knowledge Grows," (Second Lecture), Dr. J. C. Glashan.

"Radio-Telegraphy," C. P. Edwards.

EVENING MEETINGS, FALL TERM

"The New Six-Foot Reflecting Telescope," Dr. J. S. Plaskett.

"The Constitution of the Atom," Dr. J. C. McLennan.

The last lecture was held in the Y.M.C.A. Hall, ; the others in the Observatory.

AFTERNOON MEETINGS, SPRING TERM

"The Atlanta Meeting of the A.A.A.S.," Dr. Otto Klotz.

"Review of Current Progress in Astronomy," (consisting of :—"Terrestrial Magnetism," C. A. French; "Some Stellar Problems," Dr. R. K. Young; "Photometric Work and Comets," R. M. Motherwell; "Stellar Spectroscopy," T. H. Parker; "Solar Magnetism and Convection," Dr. R. E. DeLury).

"Electricity and Its Application to Telegraphy," W. A. Dier.

"Atmospheric Conditions Suitable for the Large Reflector," W. E. Harper.

AFTERNOON MEETINGS, FALL TERM

"The Evanston Meeting of the American Astronomical Society," Dr. J. S. Plaskett.

"The Geodetic Problem," W. M. Tobey.

"The New Photographic Telescope," R. M. Motherwell.

The last two meetings were held in the new Geodetic Survey Building ; the others in the Observatory.

All the lectures were of an excellent character and were well attended.

Since the presentation of the last Report nine members have been elected to the Society, and one member has been transferred from the Toronto Centre. It is my sad duty to report here the death of one of our members, Henry H. Lyman, of Montreal, who was drowned in the wreck of "The Empress of Ireland" on May 29th. Our membership now numbers 99.

The Annual Meeting of the Ottawa Centre was held December 17th, 1914, at 8 o'clock, in the new Geodetic Survey Building, Mr. R. M. Stewart, presiding.

The minutes of the last Annual Meeting were read and approved.

The Secretary then read his Report showing the satisfactory character of the meetings during the past year, and the growth in membership of the Society. It was moved by the Secretary that this report be adopted; seconded by Mr. W. E. Harper and carried.

The Treasurer then read his Report showing that in spite of extra large expenses during the year a goodly balance remained.

It was moved by the Treasurer that this report be adopted; seconded by Mr. J. J. McArthur and carried.

The following officers were then elected:

President—F. A. McDiarmid.

Vice-President—J. J. McArthur.

Secretary—Dr. R. E. DeLury.

Treasurer—D. B. Nugent.

Councillors—R. M. Motherwell, W. M. Tobey, Dr. R. K. Young.

These Officers, together with Past-Presidents, Dr. W. F. King, Dr. Otto Klotz, Dr. J. S. Plaskett and R. M. Stewart constitute the Board for the Local Centre for the coming year.

The following proposals for membership were then received: Mr. D. G. Whittle, 98 Stewart St., Ottawa, proposed by Charles A. Bowman and Ralph E. DeLury; Mr. William Stanley McClenahan, Dominion Observatory, Ottawa, proposed by Ralph E. DeLury and D. B. Nugent.

It was moved by W. E. Harper and seconded by R. E. DeLury and carried, "That an expression of thanks of the Society be sent to Mr. Thomas Donoher, of *The Citizen*,—one of our members—who has so faithfully and sympathetically reported the meetings of the Society in the past few years."

As there was no further business the meeting was adjourned.

Mr. T. H. Wingham, B.A.Sc., Secretary of the Hamilton Centre, reported as follows;—

The Annual Meeting of the Hamilton Centre was held December 17, 1914.

During the session seven lectures were held as follows:—

December 12, 1913—"Wonders of the Heavens," Wm. Bruce.
January 23, 1914—"Astronomical Phenomena, 1914," Dr. C. A. Chant.
February 13—"Cosmogony" A. A. Hibner.
March 13—"Problems of the Sun," Dr. Marsh.
April 10—"How I Sculptured the Moon," H. B. Collier.
May 22—"Horrocks" Dr. A. D. Watson.
November 19—"Wonders of the Heavens," W. Bruce, (Second Section.)

The 3-inch telescope is in the hands of one of the members who reports a considerable interest aroused in his neighborhood.

The officers and executives were all re-elected to serve another term.

The officers for 1915 are:—

President—Wm. Bruce, J.P.
1st Vice-President—W. A. Robinson.
2nd Vice-President—Rev. J. J. Morton.
3rd Vice-President—Edgar Scholes.
Secretary—T. H. Wingham, B.A.Sc.
Treasurer—Seneca Jones.
Council—Miss I. M. Walker, J. F. Harper, Mrs. J. F. Harper, J. J. Evel, J. M. Williams.

Mr. J. T. Luton, M.A. Secretary of the Guelph Centre, reported the following officers for 1915

Honorary-President—Mr. H. Westoby.
Honorary Vice-President—Mr. Jas. Davison, B.A.
President—Professor W. H. Day, M.A.
1st Vice-President—Dr. H. G. Roberts.
2nd Vice-President—Mr. H. G. B. Leadlay.
Secretary-Treasurer—Mr. R. R. Graham, B.A.
Recorder—Mr. J. T. Luton, M.A.
Council—Mrs. J. J. Drew, Miss M. Mills, Messrs. McNiece,

Luton, Graesser, Asbury, Col. D. McCrae, and Ald. H. Mahoney.

Mr. T. C. Elliott, Secretary of the Peterborough Centre, reported the officers for 1915.

President—W. A. Logan, C.E.

Vice-President—C. Fessenden, M.A.

Secretary-Treasurer—S. J. Keyes, B.A.

Council—W. I. Chisholm, M.A. ; H. O. Fisk, C. E. ; T .C. Elliott ; D. Walker, B.A. ; D. Easson, B.A.Sc. ; H. Carveth.

Mr. C. E. Bastin, B.A., Secretary of the Winnipeg Centre, reported that four meetings had been held, as follows :—

We had arranged for an open meeting on February 25th, to be addressed by Professor G. H. Ling, of the University of Saskatchewan, copy of the notice of which I enclose. Unfortunately Professor Ling was prevented from coming at the last moment by sickness in his family, and it was not found possible to arrange another meeting for him before the summer.

In order to stimulate the interest of the general public in astronomy we intend if possible to arrange for two or three open meetings during the coming year to be addressed by men from outside Winnipeg. We have in view Professor Ling of the University of Saskatchewan, and we are also trying to arrange for a member of the Regina Centre to come to Winnipeg and address a meeting, and also for a similar meeting to be held later in the year. In order to meet the expenses that will be incurred by these meetings it was resolved at the Annual Meeting to ask the Society for a grant of $50.00.

Although our membership is not very large the meetings that have been held have been very successful, and the quality of the papers and addresses delivered we believe have been of a higher standard than in previous years. In particular the discussions that have followed the papers have been very free and instructive. We feel, however, that we should have a larger

membership, and hope that the open meetings proposed and referred to above may have some effect in this direction.

During the year eleven meetings were held as follows :—

January 14, 1914 — "Observations with a Reflecting Telescope, 1913," Mr. H. W. Malpass.

January 28 — "The Spectroscope and the Spectro-heliograph," Professor N. B. MacLean, M.A.

February 11 — "The Sun," Professor L. A. H. Warren, M.A., Ph.D., F.R.A.S.

February 25 — Meeting not held.

March 11 — Observation Meeting.

March 25 — "Celestial Distances," Mr. F. Powell.

April 8 — "Jupiter," Mr. J. H. Kolb.

October 21 — "Some Physical Features of the Moon," Mr. C. E. Bastin.

November 11 — "The Measuring of Time," Dr. H. R. Kingston.

November 25 — Annual Meeting. Conclusion of Dr. Kingston's address.

December 9 — "Double Stars," Professor L. A. H. Warren, M.A., Ph.D., F.R.A.S.

Officers for 1915.

President—C. E. Bastin, B.A.

Vice-President—J. H. Kolb.

Secretary-Treasurer—H. R. Kingston, M.A., Ph.D.

Council—Rev. Father Blain, S.J.; Professor N. B. MacLean, M.A.; Professor L. A. H. Warren, M.A., Ph.D. F.R.A.S.; Mr. F. Powell.

We regret exceedingly to record the death of Mr. H. C. Howard, which occurred last summer. At the time of his death Mr. Howard was Vice-President of this Centre, and had been a member since its organization. He was an exceedingly enthusiastic supporter of the Society, and a most genial character, and had frequently made valuable contributions to our proceedings; one of his marked characteristics being his perfect willingness to do everything he possibly could to advance the interests of the Society. Mr. Howard will be greatly missed, his death leaving a gap that it will be hard to fill.

Mr. A. J. Pyke, B.A., Secretary of the Regina Centre reported as follows :—

During the year we had three meetings of the Society, at one of which Dr. J. L. Hogg, of the University of Saskatchewan addressed our members.

Last year we were forced to keep down the expenses concerning meetings, but we hope to hold a regular series of meetings commencing in January. Dr. Plaskett has promised to visit our Centre some time during the coming spring.

We leave the appropriation of a small grant to this Centre to the General Executive.

Officers for 1915.

Honorary President—Dr. R. A. Wilson, M.A.

Honorary Vice-President—Mr. N. MacMurchy, B.A.

President—Mr. James Duff, M.A.

Vice-President—Mr. W. G. Scrimgeour, M.A.

Secretary-Treasurer—Mr. A. J. Pyke, B.A.

Auditor—Mr. J. E. Campbell, B.A.

Executive Committee—Mr. W. Trant, P.M.; Mr. H. S. McClung, Mr. E. Murray, C.E.; Miss E. D. Cathro, B.A.

Mr. E. H. Cotterell, C. E., Secretary of the Victoria, B.C., Centre, reported as follows:—

The number of members in good standing at this Centre is 101 and the average attendance at six meetings has been 60 before the war and 30 afterwards.

The work of this Centre during this our first year has been of an elementary character necessitated by the work of organization and later delayed by the inability of most people to discuss any other subject than the War in Europe; however, now that the public mind has become more settled, it is the intention of this Centre to arrange for a progressive series of lectures for the coming year.

During the nine months that this Centre has operated, six meetings have been held.

"Some of the Advantages to be Derived from the Study of Astronomy," Mr. F. Napier Denison.

"The Evolution of the Idea of Astronomy," (Illustrated Lecture) Mr. E. H. Cotterell, C.E.

"Astronomy as Applied to Cartography," (Illustrated Lecture) Mr. G. G. Aitken.

"A Study of the Moon," Outdoor Meeting at Meteorological Observatory.

"Original Researches on Pendulum Movements," Mr. Napier Denison.

"The New 72-inch Reflector Telescope," Mr. A. W. McCurdy.

The Annual Meeting.

On the occasion of the visit of Dr. W. F. King, and Dr. J. S. Plaskett to Victoria in July last, the Centre held a picnic at the New Observatory Site for the purpose of meeting Dr. King. This was a very enjoyable meeting, as the site selected by Dr. Plaskett is not only admirable for its purpose but is endowed with beautiful surroundings.

The Centre has suffered a serious loss by the death of Mr. J. W. Sutton, one of its Executive Committee, who was instrumental in forming the Centre.

Mr. Sutton was a gentleman of scientific training, of broad mind and warm heart, whose loss cannot be estimated and whose good work can only be partially appreciated by the members of this Centre.

The work of the retiring President of this Centre, Mr. F. Napier Denison, should go on record, as he has been at all times in the vanguard in helping along the work of the Centre and his never failing courtesy and advise have done much to enable the Centre to get on a sure foundation for success.

It will be your pleasure to elect officers for the coming year and in that connection your Secretary would recommend that a rule for this Centre be established that all Past Presidents be retained as ex-officio members of the Executive Committee, as by that means the Centre will continue to have the advice of its most experienced members.

At the request of your Executive Committee, your Secretary invited the Honorable Dr. Young, Minister of Education, to become our Honorary President, for the ensuing year, which position the honorable gentleman has expressed his willingness to accept.

On account of other matters your Secretary will relinquish his duties at this meeting, but will always take a lively interest in furthering the objects and progress of the Centre.

In consequence of the said lethargy the Victoria Centre would do well to adopt the motto of the State Kansas—"Ad astra per aspera."

List of officers for 1915.

Honorary President—Dr. Young, Minister of Education.

President—Mr. A. W. McCurdy.

Vice-President—E. H. Cotterell.

Honorary Secretary-Treasurer — L. T. Houghton, M.D.

Executive — Messrs. G. G. Aitken, W. S. Drewry, C.E.; J. W. Lethaby, LL.B.; F. C. Swannell, B.C.L.S.; J. E. Unbach, Asst. Surveyor General; G. Gray Donald, C.E.; Augustine Symonds.

Moved by Dr. Chant and seconded by Dr. Marsh; and carried.

That in apportioning the grants for the year 1915 to the various Centres, the Council be requested to inform each Centre that the grant is to be expended for carrying on the ordinary meetings of the Society and for no other purpose, without the special consent of the Council; and that in determining the amount, the fees received from the Centre and the work done be taken into account.

J. R. COLLINS,
General Secretary.

The Treasurer's Report is as follows :—

FINANCIAL STATEMENT

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

1914	RECEIPTS, 1914		
Jan. 1	Balance in Imperial Bank	$2328.92	
	Grant from Dominion Government	2000.00	
	Grant from Ontario Legislature	600.00	
	Grant from City of Toronto	100.00	
	Grant from University Library (for exchanges)	100.00	
	Fees to date, to December 31st	829.00	
	Interest on Deposits	59.74	
			$6017.66

1914	DISBURSEMENTS, 1914		
Dec. 31	Publication of JOURNAL and HANDBOOK	2289.50	
	Public Meetings	183.65	
	Books, etc., for Library	148.51	
	Stationery and Postage Stamps	66.38	
	Bank Charges on Cheques	1.80	
	Slides for Lantern	10.00	
	Salaries	310.00	
	Rent of Rooms	200.00	
	Grant to Peterborough Centre	125.00	
	Grant to Guelph Centre	200.00	
	Grant to Ottawa Centre	125.00	
	Grant to Victoria Centre	90.00	
	P. W. Ellis & Co., Gold Medal	25.00	
	Printing Notices	10.75	
	Cash Balance in Imperial Bank	2232.07	
			$6017.66

CASH ASSETS, 1914

	Balance in Savings Dept. Imp. Bank		236.85
	Building Fund —		
	C.P.L. & S. Co. Bond at 4½ per cent.	$872.40	
	C.P.L. & S. Co. Bond at 4½ per cent.	500.00	
			$1372.40
	Cash in Imperial Bank		2232.07
			$3841.32

Respectfully submitted,

CHARLES P. SPARLING,
General Treasurer.

Audited and found correct,
(Signed) W. E. JACKSON,
LACHLAN GILCHRIST.

Toronto, January, 1915.

OTTAWA CENTRE

Financial Statement, 1914

RECEIPTS

Balance on hand	$ 57.92	
Annual Grant	125.00	
Interest	2.03	
		$184.95

EXPENDITURES

Lectures	$ 34.40	
At Home expenses	59.22	
Printing	49.11	
Y.M.C.A. for use of hall	10.00	
Postage	6.05	
Cartage	2.00	
Sundries	1.40	
	$162.18	
Cash in Bank	22.77	
		$184.95

Respectfully submitted,
D. B. Nugent,
Local Treasurer.

Audited and certified correct,
(Signed) D. Robertson,
R. M. Motherwell.

HAMILTON CENTRE

Financial Statement, 1914

RECEIPTS

To Balance, 1913	$117.67	
To Fees	4.00	
		$121.67

EXPENDITURES

Printing	$ 16.30	
Members Fees	6.00	
Lecture expenses	20.16	
Postage	1.00	
Remitted Fees	4.00	
Services (lantern)	3.00	
Rent	28.00	
Balance	43.21	
		$121.67

Respectfully submitted,
Seneca Jones,
Local Treasurer.

Audited and compared vouchers
and found correct,
W. A. Robinson.
Hamilton, December 17, 1914.

PETERBOROUGH CENTRE

Financial Statement, 1914

RECEIPTS

Members Fees	$ 50.00	
Grant from Society	125.00	
Miscellaneous sources	23.75	
		$198.75

EXPENDITURES

Members Fees	$ 50.00	
Printing	11.60	
Postage	7.13	
Caretaking	4.00	
Cab Hire	1.50	
Expenses of Lecturers	30.82	
Miscellaneous	13.50	
	$118.55	
Balance in Bank	80.20	
		$198.75

Respectfully submitted,

T. C. Elliott,

Local Secretary-Treasurer.

WINNIPEG CENTRE

Financial Statement, 1914

RECEIPTS

To Balance	$149.22	
Subscriptions	36.00	
Interest	4.35	
		$189.57

EXPENDITURES

Members Fees	$ 36.00	
Printing	20.75	
Stationary, etc.	1.85	
Postage	4.25	
Advertisements	3.78	
Wreath	8.00	
Slides	1.05	
Commission	.30	
	$ 75.98	
Balance	113.59	
		$189.57

Respectfully submitted,

C. E. Bastin,

Local Secretary-Treasurer.

Audited and found correct

Frank Powell,

H. R. Kingston.

November 25, 1914.

GUELPH CENTRE

FINANCIAL STATEMENT, 1914

RECEIPTS

Members Fees for the year 1914	$ 52.00	
Members Arrears for the year 1913	6.00	
Grants from R.A.S.C. for 1913 and 1914	200.00	
Interest on Bank Account	4.71	
Rebate on rent of Lecture Hall for 1912	12.50	
		$274.21

EXPENDITURE

Over draft 1913—as per Last Statement	$ 3.90	
Remittances to General Treasurers Members Fees	58.00	
Rent of Lecture Hall	12.50	
Caretaker	5.00	
Printing, Advertising and Postage	18.55	
Travelling Expenses of Lecturers	28.14	
Cartage on Lantern	2.50	
Credit Balance at Royal Bank	145.62	
		$274.21

Respectfully submitted,

H. J. B. LEADLAY,
Local Treasurer

Audited and found correct
H. WESTOBY,
ROBT. R. GRAHAM.
December 21, 1914.

VICTORIA, B.C. CENTRE

FINANCIAL STATEMENT, 1914

RECEIPTS

Subscriptions for 102 Members	$204.00	
Grant from Society	90.00	
Receipts for Picnic at New Observatory site	17.00	
Debit	8.45	
		$319.45

EXPENDITURES

Remittance to General Treasurer	204.00	
Bank charges on Drafts	.75	
Transportation of Picnic Party to New Observatory Site	25.00	
500 Postal Cards and Printing same	7.75	
Stationary	7.25	
Postage	12.00	
Printing	10.70	
Stenographer	11.00	
Lantern Slides	7.50	
Use of Lantern and Operator	4.50	
Rent of Lecture Hall	29.00	
		$319.45

Respectfully submitted,

E. H. COTTERELL,
Local Secretary-Treasurer.

REGINA CENTRE

Financial Statement, 1914

RECEIPTS

Balance on Hand (March 4)	$112.94	
Members Fees 1914 (additional)	21.00	
Members Fees 1915	12.00	
Interest	2.73	
		$148.67

EXPENDITURES

Re Lecture J. Hogg	$ 7.95	
Leader, Printing	4.50	
To Telescope account	120.61	
Balance, as per cash book	15.61	
		$148.67

Special Telescope Account

RECEIPTS

Mr. Duff	$ 3.00	
Regina City	100.00	
From General Account	120.61	
		$223.61

EXPENDITURES

Installing Telescope	$ 49.05	
Mr. Brashear	125.30	
	$174.35	
Deficit 1913	49.26	
		$223.61

Respectfully submitted,

A. J. Pyke,
Local Secretary-Treasurer.

Audited and found correct.

F. E. Campbell.

December 11, 1914.

NOTES FROM THE DOMINION OBSERVATORY

NOTE ON *d* TAURI

The orbit of this star was investigated by Wilson at Mt. Hamilton, by Daniel at Al'egheny and by the writer. In Daniel's publication it was stated that no lines excepting those due to the main component were recorded on their plates, though the fine-grained Seed 23 plates had been used. The writer had mentioned the lines of the second component as being visible and some data were given, though as stated "the information we have regarding it is meagre indeed ..... owing to the continued poor observing weather of the past nine months which has rendered acceptable almost any kind of plate."

It was thought advisable to review the plates and make some more, as originally intended, to settle the presence or absence of the second spectrum.

On the plates previously used some lines were ascribed to the component which in reality belonged to the main spectrum. As it happened, they were very indistinct on the plates where the velocity of the system was zero, and much more marked where separation was possible. What was recorded as the component of the magnesium line in both directions had, however, no counterparts in the zero velocity plates. Four fine-grained plates have recently been made at maximum and minimum and nodal points. The behavior of the Mg. line still stands in the way of saying that all the lines belong to one spectrum. To the red and violet of it at the proper times appear what seem to be traces of the other component, — lines which are not visible on

the plates where the velocity is zero. The evidence is meagre and these lines might be flaws in the film, but it would seem strange, if such were the case, that they should happen to show just when and where they do. Apart from the Mg. line all the other lines appearing in any of the plates where the spectra should be resolved have their counterparts in the plates where the lines should be superposed, and hence belong to the primary spectrum.

Incidentally it may be stated that the mention of the presence of the second spectrum led Shapley to investigate if the star were an eclipsing binary and such he has found it to be.

W. E. HARPER.

THE SECOND SPECTRUM IN ω URSÆ MAJORIS AND b PERSEI

My attention has been directed by Dr. Schlesinger to the possibility that the lines attributed to the second spectrum by Parker and Cannon in these binaries were spurious or were due to faint lines in the spectrum of the principal star. In consequence, the plates have been carefully reviewed and additional plates obtained in the hope of deciding this question.

These lines are definitely seen only in plates obtained near the maximum and minimum velocities of the primary, just when the separation would be the greatest; although in both cases some of the lines attributed to the secondary can be shown to have possible identifications in the primary spectrum. Furthermore, in each star some lines remain that can not be accounted for in this way. None of these lines are very well defined and there exists the further chance that they are photographic defects, but, notwithstanding the relatively small mass of the companion, there remains the reasonable explanation that they are due to the second spectrum.

The additional plates obtained at suitable phases have not

given much further information or changed the situation and it does not seem possible with our present aperture and dispersion to settle the matter. Consequently, unless some other observatory undertakes this problem, the question as the reality of the second spectrum in these two binaries and in *d* Tauri must be left in abeyance until our increased aperture is available.

J. S. PLASKETT.

REVIEW OF PUBLICATION

Publications of the Lick Observatory, Volume XI. *Photographs of the Milky Way and of Comets made with the Six-Inch Willard Lens and the Crocker Telescope during the Years 1892 to 1896.* By E. E. Barnard. San Francisco, 1913.

This is a pleasing book filled with beautiful pictures. Barnard's photographs of celestial objects have long been famous, and the present volume, in addition to explaining how he began this work, contains many fine reproductions of his photographs.

During the later days of his connection with the Lick Observatory Professor Barnard desired to see some of his photographs published, and in order to do this in a worthy manner a number of his friends supplemented the funds of the observatory. In all $2225 was contributed.

As early as 1895-6 the work of making the plates began. After considerable experimenting the "collotype" process was adopted, but when 36 plates had been printed the work was stopped. It was not up to the high standard desired. In the years that followed numerous other processes were tried but in the end the original one was adopted as the best of all. Only in the hands of an expert can it be successful and the volume certainly contains many excellent examples of it.

"Willard," whose name the lens bears, was a photographic dealer in New York, and the lens is one of those large ones used for taking portraits with the comparatively slow wet-plate process. On January 1, 1889, there was a total eclipse of the sun, visible in northern California, and through Professor Holden's

efforts a large number of amateur photographers became interested in it and took many photographs. Some of the best of these were taken with the Willard lens and it was afterwards purchased for the Lick Observatory. Before this time Barnard had tried to photograph the Milky Way but with little success. When the new lens became available it was tried and soon some beautiful and interesting photographs were produced. The lens was then re-figured by Brashear, who greatly improved the definition of the images. The diameter of the front lens is 5·85 in., that of the rear one, 6·73 in.; they are 12·8 inches apart and the focal length is 30·66 inches. At first the wooden camera holding the lens was strapped to a 6½-inch telescope, but afterwards, at the expense of Hon. C. F. Crocker, it was given a separate equatorial mounting.

On the first plate there are two views of the earth-lit moon, a view of the crescent moon with Venus near a tip and also a view of the eclipsed moon. One of the first two views shows the moon when but $24^h\ 26^m$ before it was new.

Then follow 88 photographs of the Milky Way. Accompanying each plate is given just that information required for a full appreciation of it. First we have the scale (usually 1 cm. = about 37′), the date and the length of exposure. Then the various interesting features are indicated and the location on the plate of the chief stars and other objects. As an example of the nature of the remarks made, I quote a portion of those relating to Plate 39, "Region North of θ Ophiuchi."

> "This reproduction, which is harsher than that of Plate 38, shows the remarkable structures of the sky near and north of θ very strikingly. There is a small S shaped black marking with several other minute black spots near it, something less than 2° north of θ. The beautiful details of these and others of the dark structures are very satisfactorily reproduced . . . . . .
>
> A line of considerable stars will be noticed running diagonally from near the upper left corner for about 4°. This becomes more noticeable if one inclines the plate and looks along the line."

Plate 14 shows the Pleiades, and though the exposure was only twenty minutes and in strong moonlight some of the nebu-

lous envelopes about the stars, especially that about Merope, are distinctly shown. For the next plate, also of the Pleiades, the exposure was $10^h\ 15^m$, and while this was far too long for the bright stars, the nebulosity about the fainter outlying ones is clearly exhibited.

In plates 16 and 17 is shown the remarkable nebula near ξ Persei discovered visually by Barnard on November 3, 1885, with the 6-inch telescope of the Vanderbilt University, Nashville, Tenn. The photographs show it to be a remarkable object. The region about the Great Nebula ρ Ophiuchi (Plate 36) is certainly a remarkable portion of the heavens. Here we see nebulosities of various forms, some of them enveloping stars, together with wonderful dark vacant lanes. This was discovered with the Willard lens.

Plate 49 shows the familiar star-clouds in Sagittarius and magnificent they are. The reproduction is very successful. When a magnifier is applied to it or to the two following plates, which are enlargements of portions of it, the stars seem to stand out, giving the idea of numberless stars distributed at varying distances. Many more references could be made to the star plates but lack of space forbids.

Plates 92 to 128 are photographs of comets. The great comet of 1882 was successfully photographed by Gill at the Cape of Good Hope, with the aid of a local photographer, but nothing further seems to have been done until Swift's Comet of 1892 came along when Barnard was ready to receive it. Eleven photographs of it are reproduced.

In Plate 101 is shown the photograph on which, by means of its trail, Comet 1892 V. revealed itself. This was the first comet discovered by means of photography.

Four views of Holmes's remarkable comet 1892 II. are given; then 17 plates of 1893 IV. (Brooks); and then six plates of 1894 II. (Gale). These three comets present a fine study in contrasts, though each one of them went through very curious changes.

The last plate in the collection shows the total eclipse of the sun, January 1, 1889. This was at a time of sun-spot minimum and the type of corona corresponding to it is well shown. The author speaks of the dissimilarity in the fans of streamers at the two poles, a fact the present writer had not seen referred to before.

> "The individuality of each fan is so marked that one picks out the north or south fan at a glance. The north fan is made up of definite and slender rays, sharply defined and well separated, while the southern is partly composed of broader and more diffused rays or beams, which occur more or less in bunches."

Professor Barnard for years has had the use of a much larger and more efficient photographic telescope than the Willard lens, and has produced some wonderful photographs, but these earlier pioneering efforts will always possess a special interest.

C. A. CHANT.

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

January, 1915

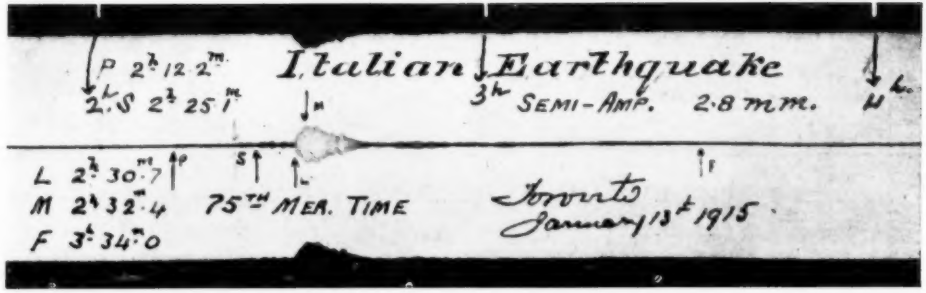
Temperature.— The mean temperature of the month was above normal over the whole of the Dominion, except in the Peninsula of Ontario, where the negative departure was from one to three degrees. The greatest positive departures were from four to six degrees in some sections of Saskatchewan and Alberta, also in Quebec and New Brunswick.

Precipitation.— From Lake Superior westward to the Mountains, the precipitation was very light, and with a few local exceptions, considerably below the normal. From the Great Lakes eastward, departures from average were not as a rule pronounced, and were in some parts a little in excess, and at others there was a deficiency. Perhaps the most notable feature was the unusually heavy snowfall in the Ontario Peninsula.

Depth of Snow.— From Port Arthur westward to the Rocky Mountains the depth of snow on the ground at the close of the month ranged between four and eight inches, while over the greater part of Ontario it was from ten inches to two feet in depth. In Quebec and Northern New Brunswick the depth was seven to eighteen inches, and in Southern New Brunswick and Nova Scotia the covering was not more than one or two inches.

Temperature for January, 1915

Station	January	
	Highest	Lowest
Yukon		
Dawson		
British Columbia		
Atlin		
Agassiz	53	16
Barkerville	39	2
Kamloops	40	2
New Westminster	50	22
Prince Rupert	54	27
Vancouver	48	25
Victoria	49	31
Western Provinces		
Battleford	35	38
Broadview		
Calgary	47	-24
Carman		
Edmonton	42	-24
Medicine Hat	42	-27
Minnedosa	30	41
Moose Jaw	37	-38
Oakbank	29	-44
Portage la Prairie	27	-38
Prince Albert	30	-42
Qu'Appelle	32	-42
Regina	33	-44
Swift Current	44	-35
Winnipeg	30	-37
Ontario		
Agincourt	44	12
Aurora	40	-17
Bancroft	41	-34
Barrie	40	- 7
Beatrice	40	-26
Birnam	42	22
Bloomfield		
Brantford	43	-20
Bruce Mines		
Chatham	42	-17
Clinton	40	-15
Cottam	40	-20
Gravenhurst	40	-34
Guelph	41	- 5
Haliburton	40	-30
Hamilton	45	- 3
Huntsville	42	-34
Kenora	22	-38
Kinmount	42	-35
Kingston	44	-24
Lakefield		
London	41	-21
Lucknow	39	-11
Madoc		
Midland	46	1
North Gower		
Otonabee		
Ottawa	41	-24
Owen Sound		
Paris	40	-19
Parry Sound	40	-22
Peterboro'	41	-28
Port Arthur	39	-34
Port Burwell	45	-21
Port Dover	41	-11
Port Stanley	40	-25
Ronville	40	-35
Sarnia		
Southampton	40	1
Stonecliffe	40	-35
Stony Creek	40	- 3
Stratford		
Toronto	47	- 1
Uxbridge	42	-16
Wallaceburg	54	-22
Welland	46	8
White River	36	-56
Quebec		
Brome	50	33
Father Point	48	20
Montreal	45	-13
Quebec	44	-22
Sherbrooke	49	-30
Maritime Provinces		
Charlottetown	46	-13
Chatham	52	-24
Dalhousie	40	-20
Fredericton	51	29
Halifax	51	- 9
Moncton	53	-10
St. John	50	9
St. Stephen	53	-19
Sussex	54	-23
Sydney	52	- 6
Yarmouth	50	6



RECORD OF THE ITALIAN EARTHQUAKE MADE BY THE MILNE SEISMOGRAPH AT TORONTO.
(Reprinted from last month's JOURNAL).

RECORD OF THE ITALIAN EARTHQUAKE, MILNE SEISMOGRAPH, VICTORIA, B.C.

Earthquake Records by the Milne Seismograph

TORONTO

R. F. Stupart, Director.

P.T. = Preliminary Tremors. L.W. = Large Waves. A.C. = Air Currents.
Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 19.5	P. T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1424	Jan. 4		10 7·7	10 10·2	10 24·0?	0·2	0 16·3	
1425	" 5	14 59·6	15 16·9	15 44·4	16 17·4?	0·3	1 17·8	
1426	" 5	16 45·0	16 51·7		17 4·4	0·2	0 19·4	May not be seismic
1427	" 5		17 28·7		17 32·1	0·1	0 3·4	
1428	" 5	23 45 8	23 55·1	0 12·7	1 27·6	0·7	1 41·8	
1429	" 7	12 37·0?			12 54·8	Less than 0·05	0 17·8	
1430	" 11	0 2·5) 0 7·1)	0 24·2	0 28·3	0 51·4	0·8	0 48·9	P. doubtful.
1431	" 12	4 39·9			4 42·9	0·05	0 3·0	
1432	" 13	7 12·2	7 25·1 7 30·7	7 32·4	8 34·0	2·8	1 21·8	Destructive Italian Earthquake.
1433	" 14	14 16·2	14 36 7		14 39·4	0·1	0 23·2	
1434	" 17	7 57·1	8 2·8		8 6·9	0·1	0 9·8	Doubtful as to being seismic.
1435	" 22		5 45·3		5 48·0	0·05	0 2·7	
1436	" 22	6 3·0			6 4·0	0·05	0 1·0	
1437	" 26	P1 24·9 S1 30·6	1 49·6 1 54·5		2 27·0	0·1	0 2·1	
1438	" 30		8 47·0		8 53·2	0·2	0 6·2	

Period 18 seconds. 1 mm. = 0″·59.

VICTORIA, B. C.

F. N. Denison, Superintendent.

No.	Date 1915	P.T. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Durat.	Remarks
		h m	h m	h m	h m	mm.	h m	
1437	Jan. 4	1 15·7	1 19·7	1 24·7	1 37·4	0·2	0 21·7	
1438	" 5	14 56·1	S15 1·6 L15 19·6	15 23·6	15 52·6	0·5	0 56·5	
1439	" 5	23 39·4	S23 43·4 L23 49·4	23 51·1	0 48·6	1·0	1 9·2	
1440	" 7	12 35·5	?	12 42·5	12 49·5	0·1	0 14·0	
1441	" 11	0 1·2	0 9·2	0 11·2	0 23·2	0·2	0 22·0	
1442	" 12	4 35·0	4 40·5	4 41·0	4 47·0	0·1	0 12·0	
1443	" 13	7 15·8	7 31·6 7 39·5	7 45·4	8 57·8	2·0	1 42.0	Italy.
1444	" 22	5 56·1		5 57·1	6 1·1	0·2	0 5·0	
1445	" 27		1 43·6 1 57·6	2 3·1	2 17·6	0·2	0 34·0	
1446	" 30	8 24·8	8 29·8	8 32·8	8 40·3	0·2	0 15·5	

Period 18 seconds. 1 mm. = 0″·54

J. Y.

MAGNETIC OBSERVATIONS

During the month of January the Agincourt photographic records of the magnetic elements indicate more or less disturbance in the Magnetic Forces throughout the month. The most pronounced effect is shown on the curves of the 1st, 5th and from the 25th to 29th and is marked by the duration of the disturbances rather than by rapid or large changes in direction or force.

The following table gives the absolute values of the magnetic elements for the month.

January, 1915		D. West	H	V	I
		° ′			° ′
	Mean of Month	6 27·0	·16053	·58701	74 43·0
	Maximum	6 47·0	·16083	·58727	
	Date of Maximum	1	29	27	
	Minimum	6 12·4	·15991	·58667	
	Date of Minimum	26	25	1	
	Monthly Range	0 34·6	·00092	·00060	
Mean Daily Amplitude	From hourly readings	0 6·9	·00029	·00007	
	From Means of Extremes	0 12·5	·00045	·00017	

H and V are expressed in C. G. S. Units.

I is the Mean of all Dip observations made during the month with the Earth Inductor, without regard to the time of day at which they were made. Two observations are usually made each week.

COMET NEWS

The first comet of the year 1915 was discovered by Mr. John E. Mellish, a well-known amateur astronomer of Cottage Grove, Wisconsin. The time of discovery is not given, but the Harvard *Bulletin* announcing it is dated February 10, and it is presumed that the comet was found on the morning of that day. It was described as a small bright comet, in R. A. 17^h, Decl. + 3, and moving slowly eastward.

The following observations are reported:

G.M.T.	R.A.			Decl.			Observer
	h	m	s	°	′	″	
Feb. 13·0619	17	6	1·9	+ 2	59	1	Aitken, Lick Observatory.
Feb. 14·0486	17	7	17 5	2	54	27	Aitken, Lick Observatory.
Feb. 15·5374	17	9	11·2	2	47	43	At Taschkent.
Feb. 15·6309	17	11	19·4	2	40	57	At Bergedorf.
Feb. 16·9862	17	11	1 6	2	40	55	Wilson, Northfield.
Feb. 17·9111	17	12	12·2	2	36	55	Burton, U.S. Nav. Observatory.

The comet is visible in a small telescope.

From observations made on February 13, 14 and 16 an orbit was computed by Professor Crawford and Miss Young, at the Students' Observatory, Berkeley, Cal.; and the following elements and ephemeris were obtained:

ELEMENTS

Time of perihelion passage	(T)	August 2·39, G.M.T.
Perihelion minus node	(ω)	225° 54′
Longitude of node	(Ω)	79° 28′
Inclination	(i)	48° 37′
Perihelion distance	(q)	1·495.

EPHEMERIS

G.M.T.			R. A.			Decl.		Light
			h	m	s	°	′	
1915	Feb.	21·5	17	16	44	+ 2	20	1·19
		25·5	17	21	42	2	2	
	March	1·5	17	26	37	1	43	
		5·5	17	31	28	1	24	1·59

By reference to Map III. of the Constellations in the HANDBOOK it will be seen that the comet is in Ophiuchus, and its position relative to the stars can be found.

The above orbit was given in *Bulletin* 577, but the next one announced that there was uncertainty regarding it as there are several possible solutions. It was intended to insert in this issue a diagram showing the comet's orbit in space relative to the earth's orbit, but this has been held over until all doubt about it has been removed.

In *Bulletin* 575 it was announced that, by means of photographs made with the 16-inch Metcalf telescope of the Harvard Observatory, Metcalf's Comet (1906 VI.) had been found; but further examination showed that the object was asteroid (393) Lampetia. The comet is much fainter than the asteroid and exposures of 1 hour, a motion being given to the plate equal to the computed motion of the comet, have failed to reveal it.

C. A. C.

ASTRONOMICAL NOTES

STAR STREAMS.— As to the meaning of the two star-streams. My explanation is that the whole mass of the sidereal star system must exercise a gravitational force on each member of the system, and they will move under this force in elongated orbits. One star-stream is the aggregate of all those stars moving away from the centre, and the other of all those moving towards it. I reviewed in a general way the evidence available at the time, including Mr. Plummer's work, to which far too little attention has been paid, and it all seemed to support this supposition. The second question is, what is the meaning of the third stream? My former answer might seem to leave no room for a third stream; but, on the contrary, it actually suggests an answer. If the stars move to and fro, there is a considerable time when they are moving neither to nor fro, the time depending upon the law of attraction, which is probably between the direct distance law (corresponding to a spherical system) and the inverse square law (corresponding to a concentration of the mass at the centre). In the case of the latter law, we are familiar with the long period of time spent by comets near their turning-points. Stream O is, then, the aggregate of all stars at the end of their orbits, and it is well known that this stream is at rest in space. There are two characteristics worth noting: this stream contains many distant stars, and this is what the explanation would lead one to expect; also it contains a large number of stars of the Orion type. Is this not a real physical connection, depending upon the origin of all those

stars? The Orion stars were formed at the same moment, and have now arrived at the same time at the pause position; but here we are in more speculative regions.—PROFESSOR TURNER, R. A. S., *Observatory*, No. 481.

ABSORPTION OF LIGHT IN SPACE UNCERTAIN.—One of the principal effects of the absorption of light in space should be a weakening of the violet light of the more distant stars relative to the red light, when we compare such stars with those which are nearer to us. The problem may be investigated in two ways: The fainter and the brighter stars in a given portion of the sky may be photographed with and without a visual color screen, and the difference of color between the bright and the faint stars may thus be determined; or the spectra of stars of the same spectral type, some of which are known to be near and others distant, may be compared with one another. Each method has its disadvantages. The color-screen method involves two assumptions: first, that the distribution of spectral types is the same among the bright and among the faint stars; second, that the faint stars are faint on account of distance. The disadvantages of the actual comparison of the spectra of the stars are that it can be applied only to comparatively bright stars, and that the accumulation of material is necessarily slow.

The most accurate comparison of the spectra of stars of the same type but of different distances may be made by obtaining their spectra on the same photographic plate. In this way the effect of differences of zenith distance and of variable transparency of the sky on the spectra is nearly eliminated. It is also necessary to obtain practical identity in the spectra to be compared, and for this purpose it has not been found possible to depend on existing catalogues. The spectra have all been classified from our own photographs made for radial-velocity determinations.

The results of about 20 photographs of this kind taken during the year leave no doubt of a difference in the violet portions of the spectrum between near and distant stars; 14 of the spectra show the distant star to be much fainter in the violet region,

while in the case of the other 6, of which 2 are of the A type, there is little or no difference. In no case is the nearer star relatively weak in the violet region.

The spectra of all of the stars used in this way were compared with a series of standard spectra at a number of points in the violet and in the red portions of the spectrum, estimations being made of their relative intensities.

. . . . . .

It is evident, from these results, that while the nearer stars are much stronger in the violet part of the spectrum than the more distant stars, the amount of this effect depends upon the spectral type, being twice as great for stars of types K_0-K_5 as for stars F_0-F_5. Since the average proper motions for the groups of small and large proper-motion stars are closely the same for the different types, we are obliged to conclude that the difference in the intensity of the violet part of the spectrum must be due largely to physical conditions in the stars themselves, the atmospheres of the stars of great intrinsic brightness absorbing and scattering the violet light more than those of the fainter stars. — PROFESSOR GEORGE E. HALE, in Director's Annual Report, Carnegie Solar Observatory, Mount Wilson, 1914.

MOVING PICTURE RECORDS OF SOLAR ECLIPSE OF AUGUST 21, 1914. — Returning from Kieff through Moscow, Petrograde, and Stockholm, we found that the eclipse had been perfectly clear at Minsk and Riga, also generally in Sweden and Norway. At Stockholm I met Dr. E. Nordenmark, who had been successful in obtaining at Solleftea, Sweden, (lat. + 63° 12′ and long. E. 17° 18′) a cinematograph record of the eclipse. It was made with a Zeiss lens of 50 mm. aperture 305 mm. focus, about six exposures being made per second, with excellent results, and about 600 quite perfect pictures of the corona, the coronal ring being clearly caught for several seconds of the partial phase. His film shows the possibilities of rapid photography in eclipse work and augurs well for future successes in automatic photography of the corona. — PROFESSOR TODD in *Observatory*, No. 483.

J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

QUERY

Easter Sunday is the first Sunday which comes after the fourteenth day of the Paschal moon, the Paschal moon being defined to be that moon the fourteenth day of which occurs on March 21, or next after that date. This fourteenth day is approximately the time of full moon and for brevity of statement let us consider it such. Suppose, now, that the Paschal moon is full at 1 a.m. on Saturday, March 21, Greenwich Mean Time. That moment is 8 p.m. on March 20 in Eastern America. At Greenwich, then, Easter Sunday would be on March 22, but in America not until the next lunation.

How is this difference in longitude allowed for?

Is the date March 21 the civil or the astronomical day?

Who is the supreme authority in determining the precise date of Easter?

Are these matters fully explained in any published work?

Having received various inquiries regarding the date of Easter, the Editor put them in the above form and sent them to the Director of the *American Ephemeris and Nautical Almanac*, with the statement that the readers of the JOURNAL would be greatly obliged to him if he would supply answers. The information received in reply is very complete and explicit, and our sincere thanks are tendered to Professor Eichelberger for the trouble he has taken.

ANSWER

1. The rule for Easter Day quoted in your letter is a legacy from the early centuries of the Christian era, and is still recognized by all branches of the Christian Church as of binding authority.

2. In applying the rule, however, practical difficulties are

encountered such as those indicated by the questions contained in your letter. To avoid these difficulties and to secure a more certain Easter date, the Churches have been willing to sacrifice accuracy; and the universal practice now is not to take the ancient rule literally, but to substitute a definite mathematical process; or what is the same, to substitute for the moon in the heavens an altogether imaginary moon, which is not even the mean moon of the astronomers, but which moves in such a way that the imaginary new moon is always later than the astronomical new moon, sometimes by two or even three days; this imaginary or ecclesiastical moon it is, that determines the date of Easter.

3. By this method which, moreover, disregards fractional parts of a day, not the instant but the date of Paschal Full Moon is determined; and determined not for one meridian only, but for the whole world. This end is accomplished by means of certain constants and a purely arithmetical computation, or by means of convenient tables based upon the constants; so that the Day of Paschal Full Moon is known for all time with the same certainty, although not with the same facility, as are Christmas and New Year's; and like these latter, Paschal Full Moon and Easter coincide each with a day of the local civil calendar; March 21 in the rule is also the local civil day.

4. The whole scheme is highly artificial and is somewhat different in the Eastern and in the Western Churches; thus, in Russia, where the Julian calendar is still used, Easter Day is sometimes five weeks later than with us.

5. At the present time the Roman Catholic Church and the various Protestant denominations are at one as to the date of Easter; they all make use of the Gregorian determination, which is a particular form of the scheme outlined above and which was introduced in 1582 by Pope Gregory XIII at the same time with the changes made by him in the Julian calendar. The Gregorian Easter date was adopted by Act of Parliament in 1752-3, and on the same authority tables giving results in conformity to the Gregorian usage were inserted in the prayer-

book of the Church of England, where they may be seen to this day; the same tables appear in the prayer-book of the Protestant Episcopal Church in America, and by reference to these tables it becomes a very easy matter to find the Easter date in any year up to A.D. 8500; it is only in a technical sense that these tables differ from the Gregorian: Pope Gregory adopted the Epact as the argument for finding Paschal Full Moon, while the Church of England retained the Golden Number as being the very ancient and very convenient argument for the same purpose.

6. The date of Easter may also be found without the use of any tables whether English or Roman, and to that end we quote from the Roman Catholic prayer-book the following, which is a curtailed form of Gauss's rule and is applicable to the twentieth and twenty-first centuries:

"1st. Divide the date of the year by 19, and call the remainder a;

2nd. Divide the date of the year by 4, and call the remainder b;

3rd. Divide the date of the year by 7, and call the remainder c;

4th. Divide $19a + 24$ by 30, and call the remainder d;

5th. Divide $2b + 4c + 6d + 5$ by 7, and call the remainder e;

Then Easter will be the $22 + d + e$ of March; or the $d + e - 9$ of April.

Exceptions: 1st. When Easter would fall on April 26th, put it back to the 19th. 2nd. When it would fall on April 25th, put it back to the 18th, unless $d = 29$ and $e = 5$."

7. Supreme authority there is none, in case of dispute; each Church must settle the matter for itself; or each country for itself where there is union between Church and State. And so, in fact, the whole matter has been settled so far as Western Christendom is concerned, by slow but complete accessions to the Gregorian rule.

For reference:

Woolhouse's *Measures, Weights and Moneys of All Nations.*

Encyclopædia Britannica ; article, Calendar.

Ideler's *Handbuch der mathematischen und technischen Chronologie.*

Lersch's *Einleitung in die Chronologie.*

W. S. EICHELBERGER,
Professor of Mathematics, U.S.N.,
Director, *Nautical Almanac.*

FALL OF AN ÆROLITE

Most of your readers will have heard of the fall of an ærolite near Wigan, Lancashire, England, on the 13th of October, 1914. It is the largest that has fallen in England for a considerable time and was well seen as a brilliant meteor in falling. It seems to have presented some unusual features, but the accounts given cannot be relied on, many of those who saw it getting a fright under the impression that it was a new German war-engine.

It will be seen that in the Catologue of Aerolites by the late Mr. Harvey and myself, published by the Royal Astronomical Society of Canada, there were more ærolite falls on the 13th of October than any other day in the year — the number in the principal Catalogue being five. I also find, in a list of the dates on which there were an unusually large supply of brilliant meteors or fire-balls, which Mr. Denning supplied to *The Observatory* in 1879, October 13-15 is given as one.

The last previous fall on this date was in 1852. Some of the earlier falls seem to indicate a period of in or about 31 years but the evidence on this point is by no means decisive. I think, however, that the ærolite of October 13, 1914, was pretty evidently a member of a known shower.

W. H. S. MONCK
Dublin, Ireland.

. . . . . .

A reference to this meteorite was made in Notes and Queries for last month. The Catologue of Aerolites to which Mr.

Monck refers was printed in *Selected Papers and Proceedings* for 1902-1903, page 12.

A BRIGHT METEOR IN ALBERTA

The following observation was reported by Mr. A. D. Wilmer, meteorological observer at Riviére-qui-barre, Five Lakes District, Alberta. (Long. 113° 45′ W., Lat. 53° 45′ N., approx).

At about 6 p.m. 22nd January, 1915, I saw a remarkably fine "falling star." It first appeared at about two-thirds of the distance between Gemini and the coulter of the Plough; travelled towards a point about 10° below the farthest handle star Benetnasch; endured 7 to 8 seconds; movement notably slow; appearance, pale greenish white light; much "smoke." It seemed at the last moment to blaze up and then break to pieces; not much trail left behind.

AUDIBILITY OF THE AURORA

As my readers already know, I am much interested in the question of the audibility of the aurora, and any real evidence bearing upon the matter is very welcome.

In the Dawson *Daily News* for January 16, 1915, (which is a four-page paper and sells at 25 cents a single copy) is a despatch from Los Angeles, California, as follows:

"Writers have tried to describe the beauty of the northern lights, but they are indescribable," said A. B. Ferguson, a mining man of Iditarod, Alaska, who is registered at the Stowell hotel.

"Drawing a whisk-broom across silk would more closely produce the effect of the lights than anything else," continued Mr. Ferguson.

"In all the colors of the rainbow, the lights fall like a large drapery. Usually they make a swishing sound and sometimes when the lights are near the earth a weird, popping sound is heard. Back in January, 1898, I had an experience while driving a dog team up in the interior. It was just before daylight when the lights fell so close to earth that the popping sound scared the dogs — and I guess they scared me worse."

I am afraid the above cannot be accepted at its full face value, but it seems hardly fair to rule it out entirely. I would thank the thoughtful person who sent the paper and hope to receive further reports from high latitudes. C. A. C.